Science Lab Reconstruction
- Renae Lewis & Traci Burgess

CURRENT USE OF TECHNOLOGY IN CLASSROOM

At Salmon High School we incorporate a variety of technology throughout the science curriculum. The difficulty, however, is that most of our equipment is outdated or there is not enough of it for the students to work in small groups. Our high school was built in 1979, and in order to save money, the district moved all of the lab equipment from the old school to the new. We still use a lot of this equipment. Over the last five years, the department has tried to update the labs of physics, chemistry, and physical science, but we have found it to be a challenge with Idaho's shrinking education budget. With the Qwest Foundation grant the science department would replace aging equipment and supplement supplies so that students reap the benefits of hands-on approach to science education.

A large part of or technology is for data collection during lab. The math and science department share a set of TI-86 calculators. These calculators are used by the advanced classes to store data from labs measuring such things as vectors, velocity, acceleration, conservation of energy, and changes in temperature. These calculators also work well for teaching graph analysis, as the students can immediately see their recorded data in graph form. This aids with concepts like standard curves and best-fit graphs. We also have one set of hand-held probes that work in conjunction with the TI-86s. There are six probes that measure a variety of tests, but can be used only for demonstration purposes since there is only one of each. We also have an electronic scale in chemistry and physics. It is important that the students learn how to operate this since they will be expected to use them in college labs. We had two of these scales, but unfortunately one broke. It was so old that the parts cannot be found to fix it. The students are once again waiting in line to finish labs, and lessons that could be done in one day are now taking two.

The students also employ technology when studying motion. We have spent a large part of our budget trying to beef up this unit. In the last three years our department has purchased a group of small-scale hovercrafts, a rollercoaster pegboard with an accompanying virtual program, and a mini-projectile launcher. Together with a set of hand-held timers, these labs provide the ability to study phenomena such as Bernoulli's principle of flight, Newton's three laws of motion, and Galileo's gravitational constant. Using this technology, students also learn to calculate velocity, acceleration, force, work, and kinetic and potential energy. The weak link in all of these labs is the stop clocks. They lend themselves to experimental error because of human mistakes, and they are continually breaking. We purchase a new set of sixteen every year; we are forced, however, to buy the cheapest clocks available. After being used for repeated labs by approximately half the school during the year the clocks have a short life expectancy.

We have also purchased new technology for the study of waves and energy, including a ripple tank with some attachments, a diode laser, and a spectrometer for seeing the light spectrum. These purchases improve this unit significantly. The kids enjoy the labs and the test scores for this unit have shown a marked increase.

IMPACT OF TECHNOLOGY IN THE CLASS

In the last three years, the science department at Salmon High School has been trying to better prepare students for what they will face when they leave. This has included not only realigning our curriculums to Idaho State Standards but also redesigning them to include more technology and scientific advances. By adding these to our daily activities we feel we have developed a more hands-on approach. We have seen the impact of including both basic and cutting-edge technology in a number of ways, including increased test scores, larger class numbers, improved mastery performance, and higher numbers of graduates entering science- related fields.

Students receive a large portion of their grades by showing concept mastery of lab skills, including basic skills, (such as using triple beam balances, and graduated cylinders on the freshman level) to advanced concepts (such as being able to produce different wave types in a ripple tank on the senior level). These skills are at least as important as memorizing and regurgitating information on an exam. We feel confident that the majority of our students leave our programs with the basic skills to function in a college-level science lab.

Since we have started our classroom and lab improvements, we have noticed a large decrease in the number of regular students who fail and in the advanced students who earn a *C* or below. We have also observed an increase in test scores in both the classroom and on standardized tests. Our ACT scores among students who have taken advanced science classes have risen five percent on average over the last three years. We also have more students enrolling in our advanced classes: the Physics program has grown from eight students to twenty-two, and Chemistry has increased from eighteen to twenty-nine. We believe that offering students more technology is directly related to the growth of these programs.

The last indicator that we have observed that shows technology's impact on our program is a growing number of students pursuing science related fields after they graduate from Salmon High School. From the graduates of 2005, we have students majoring in: chemistry (1), pre-pharmacy (1), pre-medical (2), biology (1), and engineering (3). We realize that students' interest may change as they get older, but we feel that out of a class of eighty that that is a large percentage with an interest in science.

USING TECHNOLOGY TO ENHANCE LEARNING OPPORTUNITIES

In the study of physics and physical science one important unit of study is the mechanics of motion. Much of the technology purchased by this grant would enhance projects within this unit. Examples of two such projects are the "Hovercraft Madness" and "The Great Mousetrap Car Races".

Every year freshmen at Salmon High School culminate their study of motion by creating a mousetrap-powered car and analyzing its motion. Students spend a week designing and building their cars following limited guidelines and their imaginations. All students participate in a day of competitions that include longest distance traveled, fastest overall car, and most original design. All gather data and make calculations based on times taken by digital stop clocks. This data gives students a general idea of the car's velocity, acceleration, and generated force a large amount of human error, however, is involved due to the stop clocks. With the addition of the photo gates and smart timers, students would be able not only to negate this error, but add more experimental data to their information bank. They would be able to break down their car's motion from the time it left the blocks until it stopped. By knowing such things as where there is the greatest amount of acceleration, how much force their power source is generating, and where preventable friction is occurring, students can increase the efficiency of their cars for the competitions at the end of the week. In the process students learn to use basic equipment that they will utilize in college science classes and witness how technology can decrease experimental error in data collection.

The study of mechanics is rooted in Newton's Three Laws of Motion. A great way for students to observe, measure, and finally understand them is with hovercrafts. Students observe small-scale hovercrafts by using them in lab. In order to study Newton's third law (every action has an equal and opposite reaction) students design and build a hovercraft to experiment with. By purchasing a large scale craft, students would experience all three principles firsthand. By riding on a disc hovercraft, the student can see that they will move only in a straight line both upward and forward/backward unless someone turns them (an outside force). They can also measure the amount of force required to lift them self and convert that into horsepower being generated. They can also feel and diagram the action of the blower pushing them off the ground and causing them to move. This would be a great way to introduce the effects of fluid (air) friction opposed to sliding friction caused by the ground.

The ways that these purchases could be utilized throughout the year are almost limitless. We feel it is important that science be taught through experimentation rather than book and lecture. We have realigned our curriculum to reflect that belief. Replacing equipment that in some cases is over thirty years old is the problem. The materials that we will purchase to enhance the technology in our classrooms will be used extensively during the entire school year. The photo gates and smart timers can be used in any mechanics lab, whether it is motion, simple machines, transfer of energy, etc.

USING TECHNOLOGY TO CREATE INNOVATIVE LEARNING

This grant would provide the science department at Salmon High School the ability to create new units and projects as well as revamp existing ones. It would also open the door to more cross-curricular opportunities between the math and science departments. These units would include an examination of human motion and a project calculating the acceleration constant of gravity.

A unit combining junior chemistry and freshman physical science would study motion of the human body and the energy to requirements to do so. Using the velocity tubes, freshmen would examine different types of motions including constant velocity and constant acceleration. While learning this, chemistry students will be studying life chemistry. During this unit students will complete a dietary analysis and create a calorimeter to measure energy in calories. Students from both classes will then team up in groups of three (two freshmen to every junior) and meet on the track. Using the photo gates and smart timers, students will time themselves while duplicating the motions that they have studied with the velocity tubes. Using these times students will calculate the amount of energy consumed for each type of motion. The finished product will include a description of the motions studied, exercises that represent each, and the pros and cons of each type of exercise. The journals will also include an example of a week-long diet with calorie counts and an overall total of calories burned versus consumed for each day of the plan.

A study of both simple machines and gravitational acceleration would be completed by doing another cross-curricular project between physical science and physics, involving marshmallow catapults.

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After observing the pulley demo board, students would study the mechanical advantages of fixed and free pulleys and multiple pulley systems. Students can also use the pulley force table to study equilibrium and force vectors. Instructors will compile teams of freshmen from honors physical science and physics. Each team will make a marshmallow catapult to try to launch their marshmallow the farthest. This project will allow students to analyze projectile motion compared to two dimensional motions. With the photo gates and smart timers, students will time the flight of the marshmallows to calculate both the ascent of the marshmallow and the descent. They then can calculate the acceleration rate of gravity on a free-fall object. After analyzing the flight of a marshmallow, they will compare it to the flight of a marble. Students will be compare how surface area and weight differ in there influence upon free fall. Combining advanced students with younger students will have a two-fold effect: the older students help the younger grasp difficult concepts and they will encourage the younger students to take advanced classes in there junior and senior years.

Salmon High School is currently one of the lowest funded schools in the state of Idaho. As of October 2005 out of 363 students, 107 qualified for free or reduced lunch. While we use our technology extensively, it is not enough to prepare our students for the competition they will be seeing in both college and the workforce. Currently enrollments include one hundred thirty-five freshmen taking physical science, twenty-two seniors in physics, and twenty-nine juniors/seniors in chemistry. That is roughly fifty percent of the student population that would be able to take advantage of the technology this grant could provide through out the school year.

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Quest Foundation for Education Grant Expenditure Plan

	100	200	300	400	500	
Activity	**Salaries**	**Benefits**	**Contractual Agreements**	**Materials and Supplies**	**Capital Objects**	**TOTAL**
Finding equilibrants, resultants, and components of vectors				Super Pulley Force Table 195.00 Hanger Set $65.00		$260.00
Resolving vectors, measuring forces, torque experiments, center of mass, simple machine experiments, friction, simple harmonic motion				Introductory Mechanics System $669.00		$669.00
All experiments needing to be timed throughout the year (ex. velocity, acceleration, and momentum)				10 Smart Timers $249.00 each 18 Accessory Photogates $59.00 each		$3,552.00
Kinematics, coefficient of friction, acceleration, velocity, momentum, spring constant, sliding friction, conservation of energy, conservation of momentum, Newton's Three Laws of Motion, simple harmonic motion, gravitational constant, viscosity, equation of motion, displacement, and force				10 PAScars (sets of 2) $85.00 each; 10 PAScar accessories $20.00 each; 3 Classic Dynamics Systems $364.00 each; Small Steel Balls $15.00; Pulley Demonstration System $299.00; 10 Constant Velocity Tubes $59.00 each; Hovercraft $200		$3246.00
All experiments needing mass measurements				2 Electronic balances $245.00 each		$850.00
Wave patterns, wavelength, frequency, and wave theory				Mechanical Strobe Accessory $295.00		$295.00
Law of Reflection and Refraction, image formation, dispersion, total internal reflection, color filtration, prisms, polarization, diffraction, spherical lenses, projectors, magnifiers and telescopes				Introductory optics System $613.00		$613.00
Shipping and Handling						$474.25
TOTAL	**$0**	**$0**	**$0**	**$9458.00**	**$0**	**9959.25**